

Magnesium Finishing for OEM And Overhaul



TECHNOLOGY APPLICATIONS GROUP
EXCELLENCE IN MAGNESIUM SURFACE PROTECTION

ASETSDefense 2011 February 8-10, 2011

Bill Elmquist

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE FEB 2011		2. REPORT TYPE		3. DATES COVERED 00-00-2011 to 00-00-2011	
4. TITLE AND SUBTITLE Magnesium Finishing for OEM And Overhaul				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Technology Applications Group,810 48th Street South,Grand Forks,ND,58201				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES ASETSDefense 2011: Sustainable Surface Engineering for Aerospace and Defense Workshop, February 7 - 10, 2011, New Orleans, LA. Sponsored by SERDP/ESTCP.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 36	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Finishing Options

Typical for Magnesium

Conversion Coatings - Used Most Commonly During Overhaul

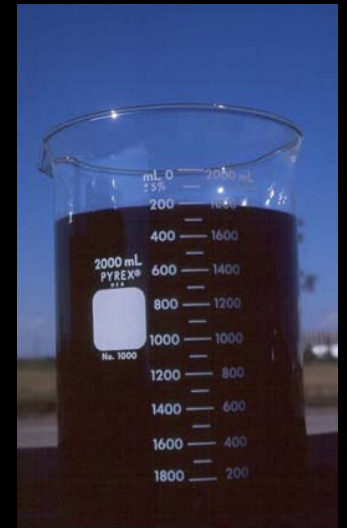
- Dow 7, created in the 1940's
- Dow 9, created in the 1940's
- Chrome Manganese, created in the 1940's

Anodize Coatings Used Most Commonly for New Build

- Dow 17, created 1942
- HAE, created 1955
- TAGNITE® , created 1992
- Keronite® , created ?

HAE

HAE, named after inventor Harry A. Evangelides, was patented in 1952. The very high alkaline solution has a pH of approximately 14 and should be operated between 70 and 86° Fahrenheit.



CHEMICAL

Hydroxide (*extremely caustic*)

Fluoride

Potassium Permanganate (*strong oxidizer*)

Aluminum Hydroxide

Sodium Phosphate

Concentration (g/L)

120

35

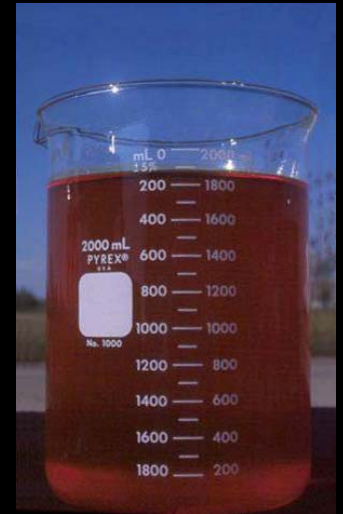
20

34

35

Dow 17

The Dow Chemical Company invented Dow 17 in the mid-1940's. The electrolyte has a pH of approximately 5 and should be operated at or above 160° Fahrenheit.



CHEMICAL

Concentration g/L

Ammonium BiFluoride	360
Sodium Dichromate (<i>hazardous chemical</i>)	100
Phosphoric Acid	97



Developed in the 1990's with the Clean Air & Clean Water Act in mind, TAGNITE[®] was designed as a replacement coating for Dow 17 and HAE. The electrolyte's pH range is 12.8-13.2 and operates below room temperature (40-60°F)



CHEMICAL

Hydroxide

Fluoride

Silicate

Concentration (g/L)

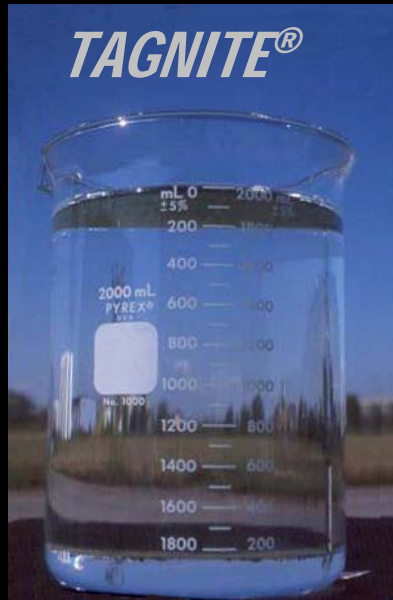
4 - 8

5 - 10

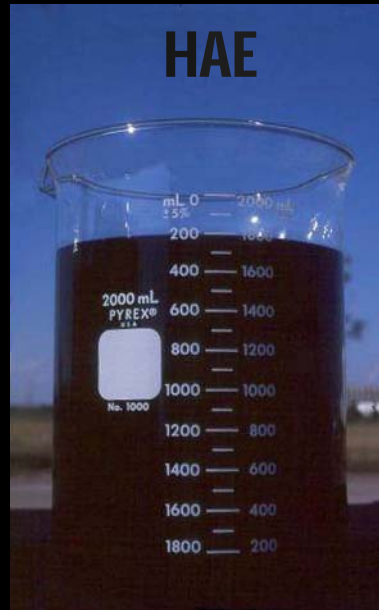
15 - 25

No Chromates or Heavy Metals

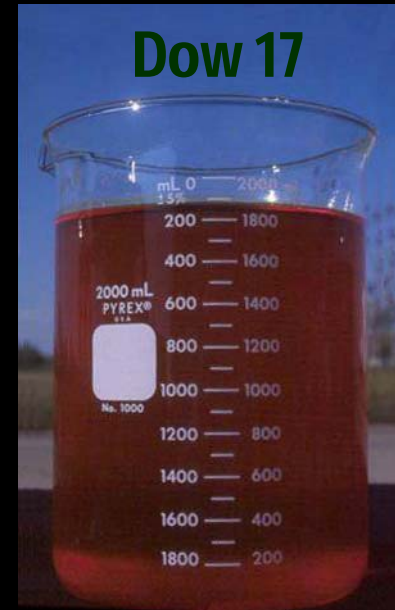
Chemical Composition as a Percentage of Water



5% * chemical
concentration



25%* chemical
concentration

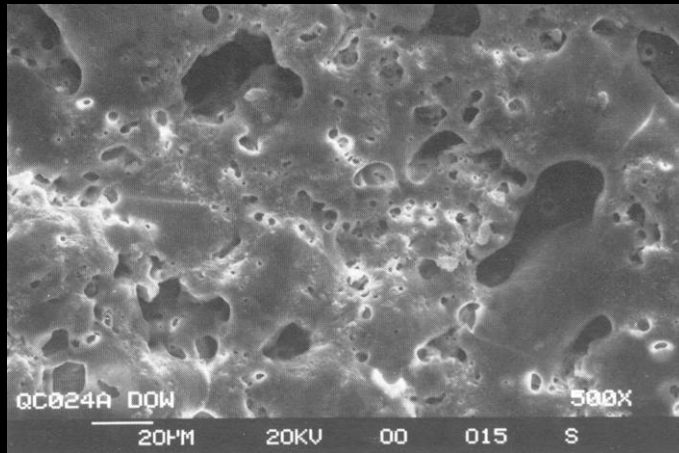


56% * chemical
concentration

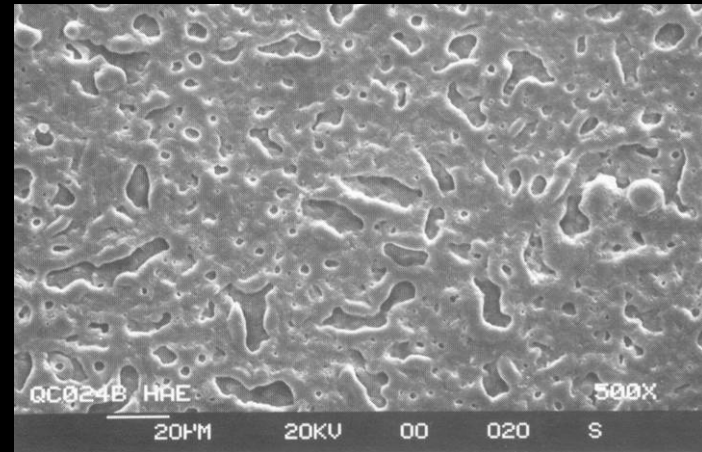
HAE contains heavy metals; Dow 17
contains heavy metals and chromium

*Approximations

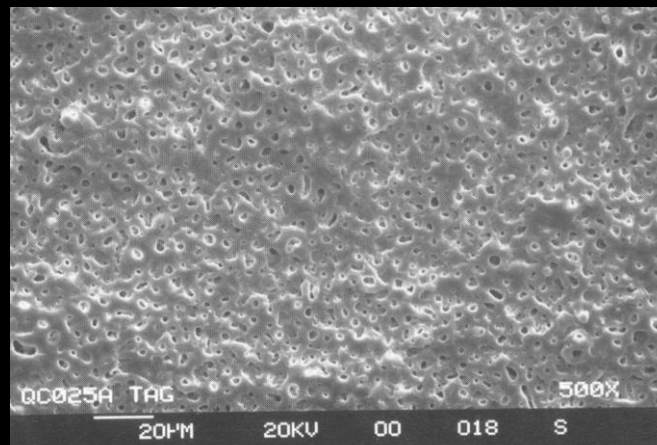
Coating Morphology



Dow 17



HAE



TAGNITE®

All photos shown at
500x magnification.

Corrosion Testing



Superior Corrosion Resistance



TAGNITE®



HAE



DOW 17

TAGNITE®, HAE & Dow 17 (Type I) on magnesium alloy
ZE41 after 168 hours in salt spray

Only Tagnite Provides Inherent Corrosion Resistance

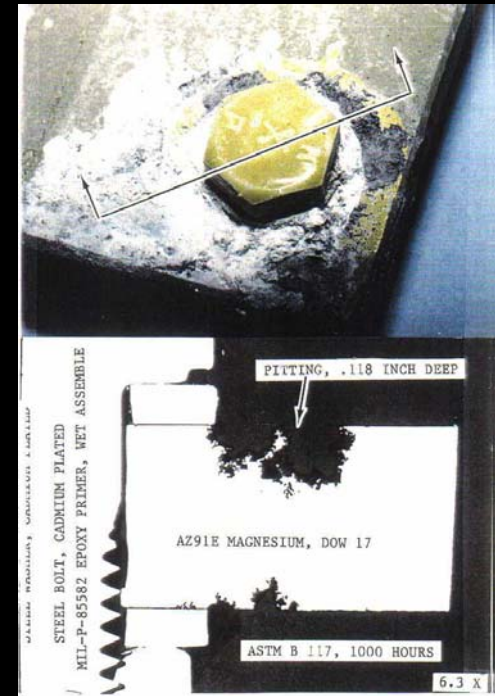
Superior Galvanic Corrosion Resistance



TAGNITE® 8200



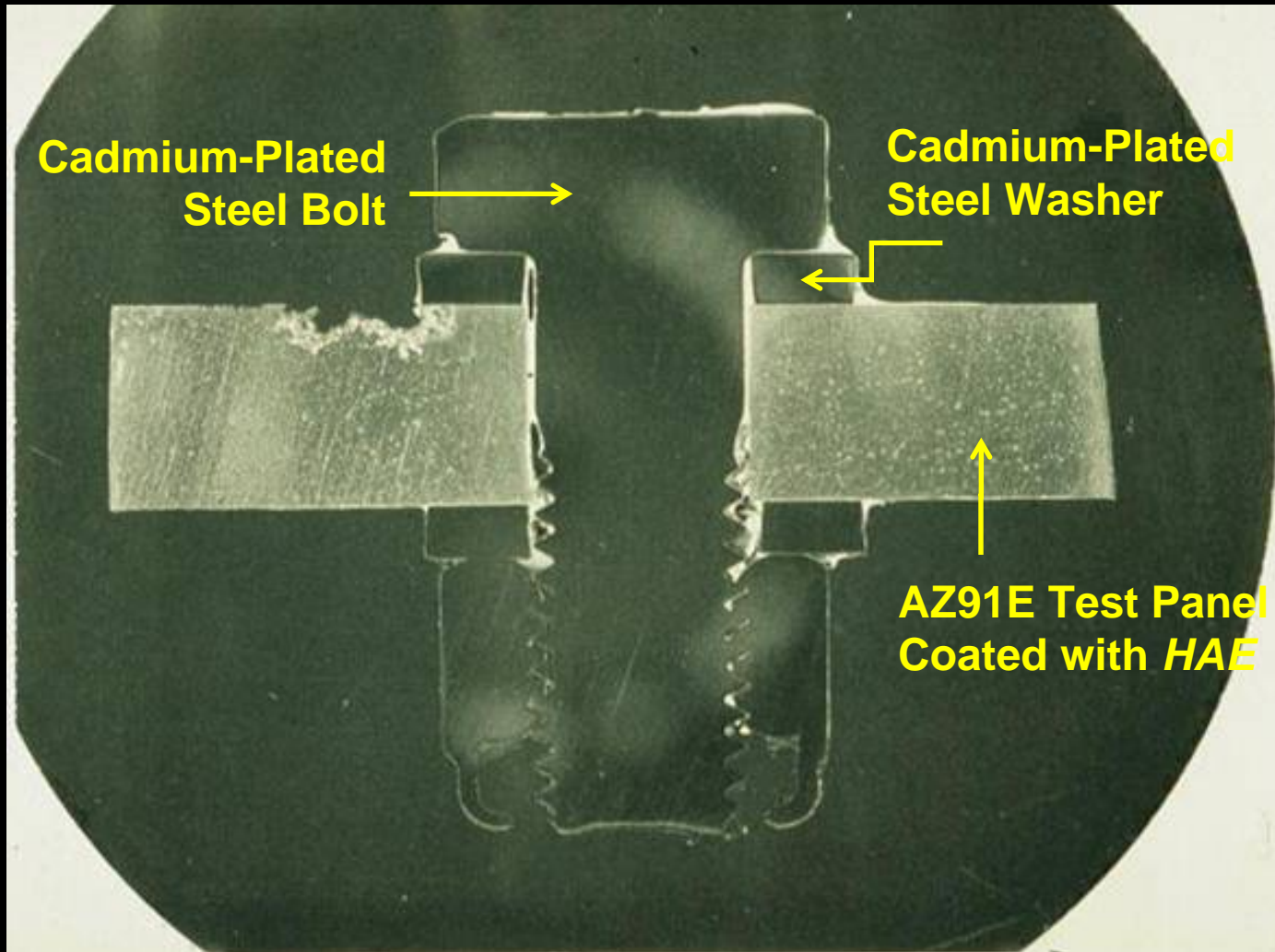
HAE



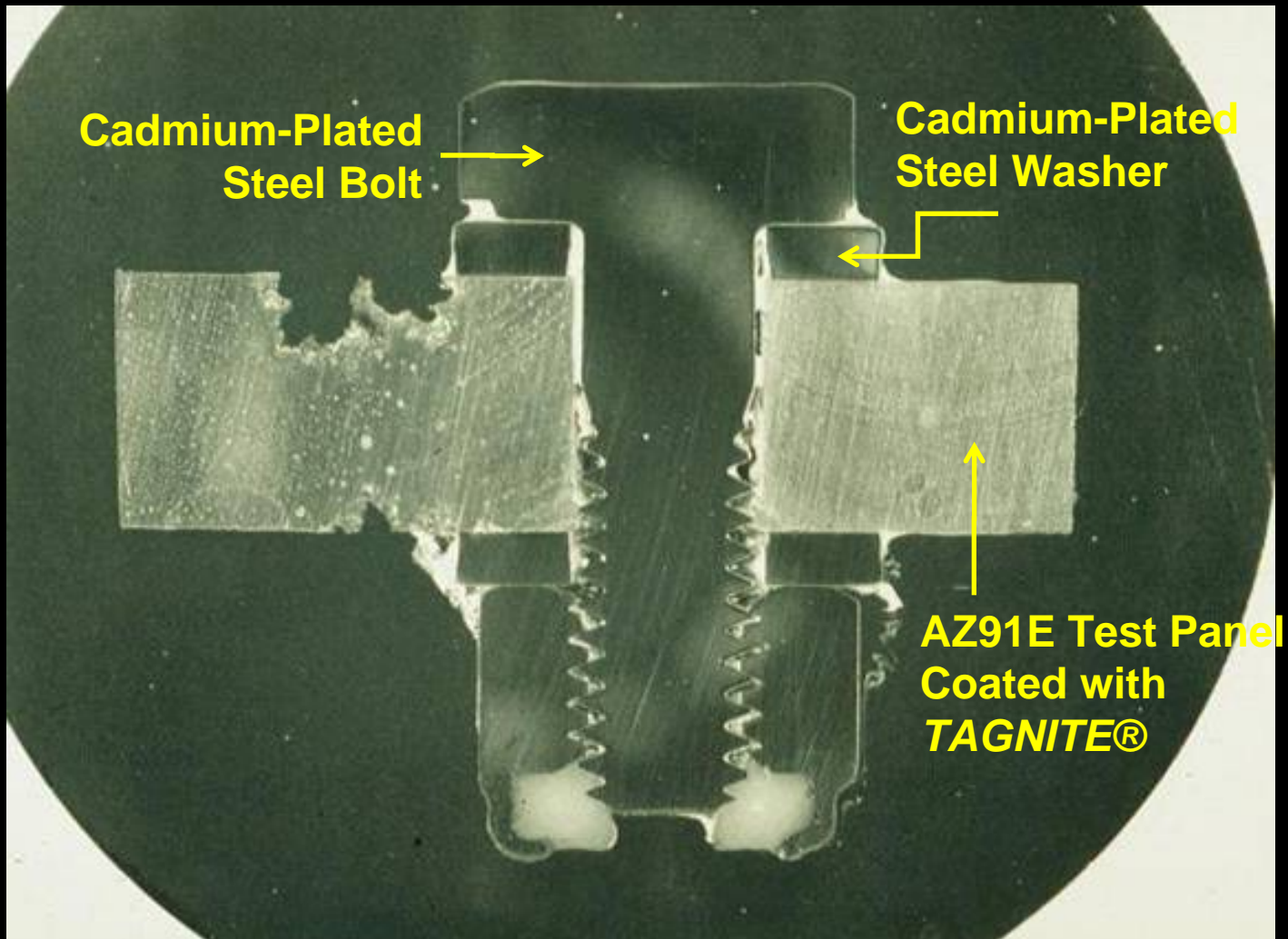
DOW 17

AZ91E sand cast magnesium test plates assembled using cadmium plated steel bolt/washer & placed in salt spray (ASTM B117) for 1000 hours.

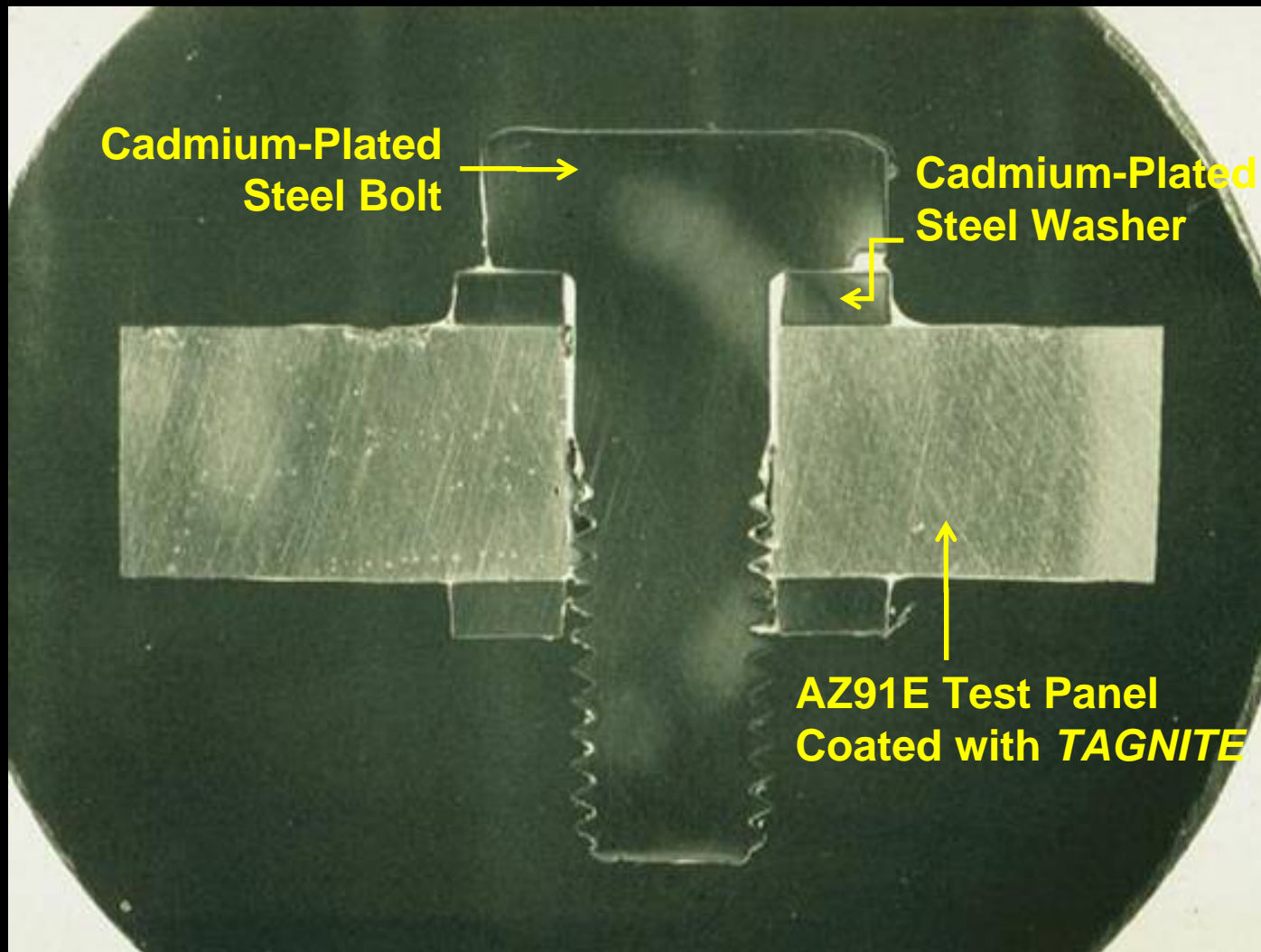
Galvanic Corrosion - HAE



Galvanic Corrosion – Dow 17



Galvanic Corrosion – TAGNITE



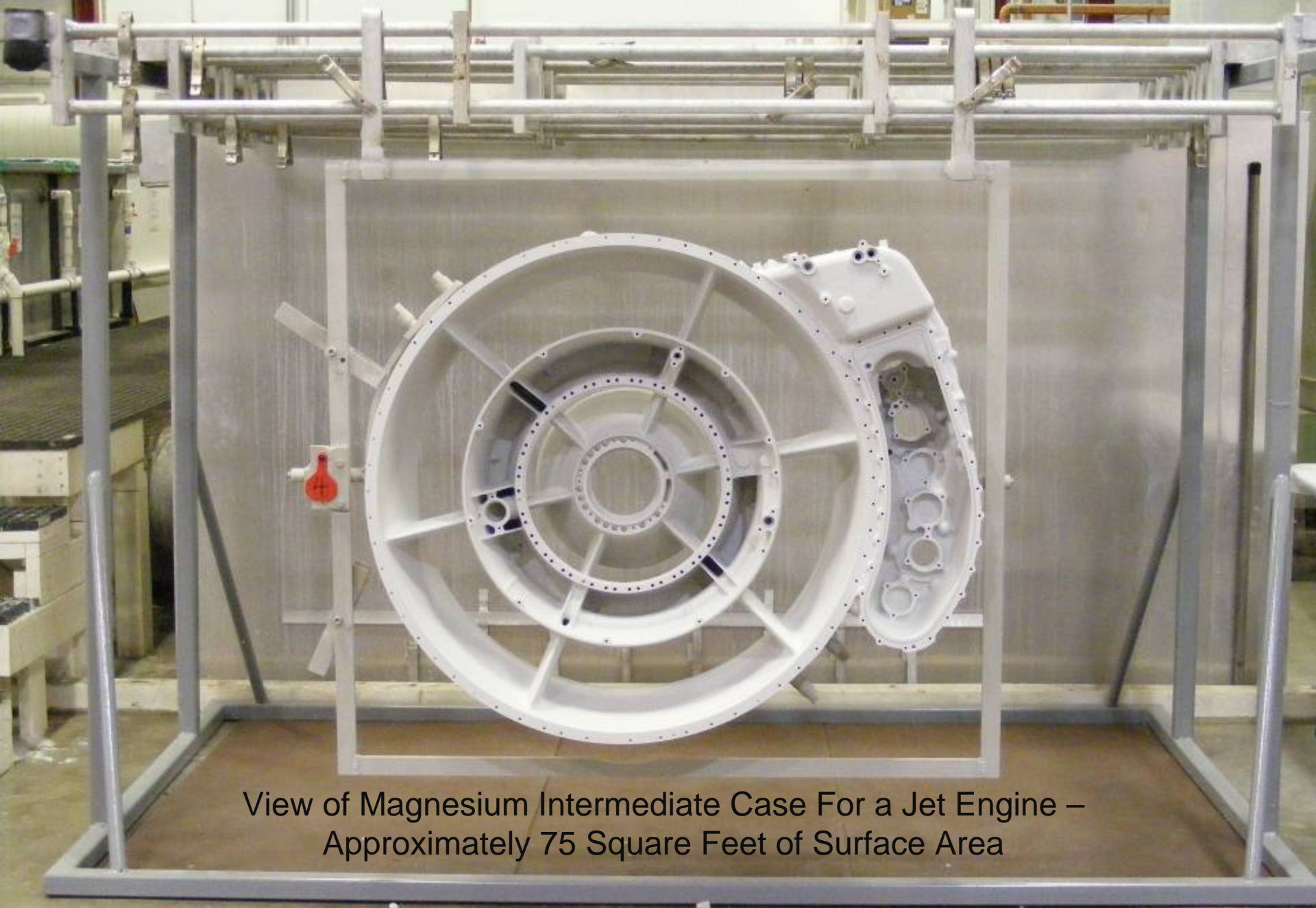
Environmentally Clean

Tagnite has been carefully studied and reviewed and by the EPA's Design for the Environment Program and has been granted the status of Partner Formulator

Tagnite Contains

- No Chromium(VI)
- No Heavy Metals
- No Sulfuric Acid
 - No Nitric Acid
- No Hydrofluoric Acid





View of Magnesium Intermediate Case For a Jet Engine –
Approximately 75 Square Feet of Surface Area



CH-53



AH-6



F-35 Fighter



F-22 Fighter



MD 500/600



USMC EFV



AH-64 Apache

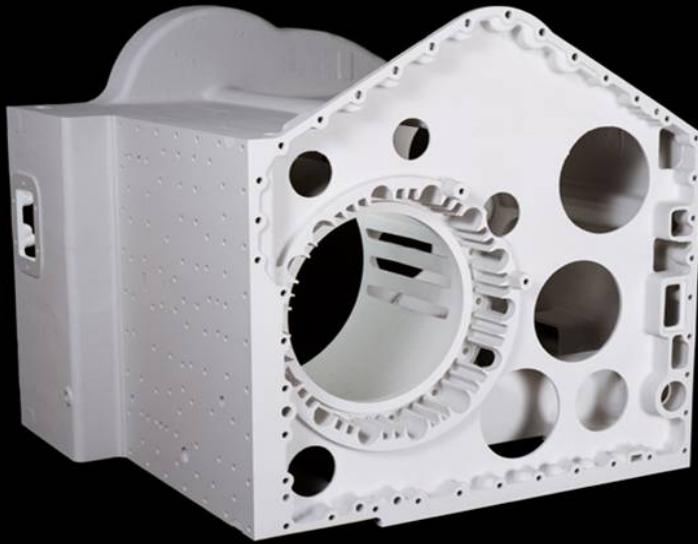
Widely Specified



KC-135 Tanker



B-52 Bomber



Magnesium Transmission Housing



Magnesium Oil Pan



Magnesium Gearbox



Magnesium Jet Engine Gearbox

- Last B-52 was built in 1962
- Air Force wants to keep them going until 2040
- The B-52 utilizes many magnesium components including several in the pilot yoke/Steering column
- The majority of these 48 year old castings are still serviceable
- By selecting Tagnite the Air Force was able to eliminate hexavalent chromium and attain corrosion resistance superior to standard chromate conversion coatings typically used during overhaul
- Tagnite has been employed now on 11 different part numbers on the B-52 Bomber and 7 more part numbers are in the approval process



TECHNOLOGY APPLICATIONS GROUP
EXCELLENCE IN MAGNESIUM SURFACE PROTECTION



Tagnite is regularly
applied to used
magnesium castings on
the B-52



London Colborne, Co Plant
B-52 Stratofortress
A/N 20-12000-002
For Training Purposes Only

48 Year Old+ Magnesium Castings

**Better Protected in 2011
Than When They Were
Factory New**



48 Year Old+ Magnesium Castings

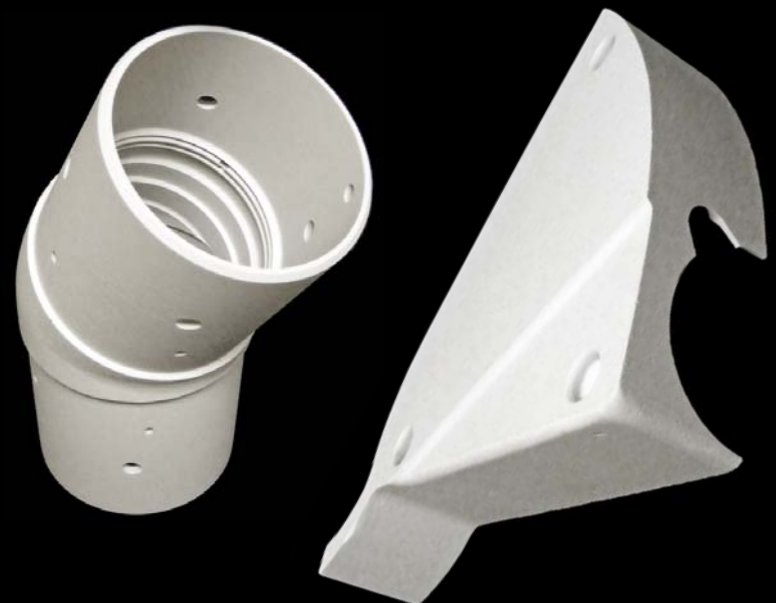


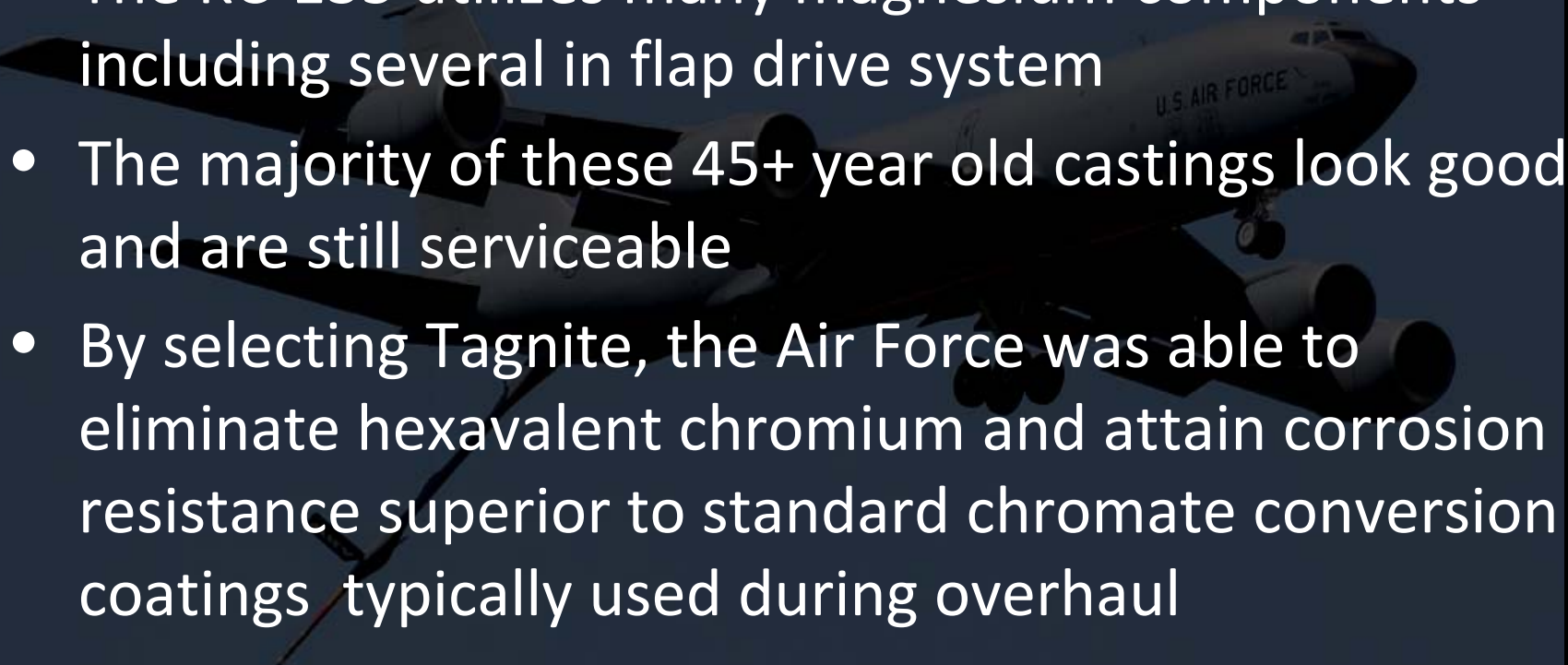


TECHNOLOGY APPLICATIONS GROUP
EXCELLENCE IN MAGNESIUM SURFACE PROTECTION

**48 Year Old+ Magnesium
Castings**

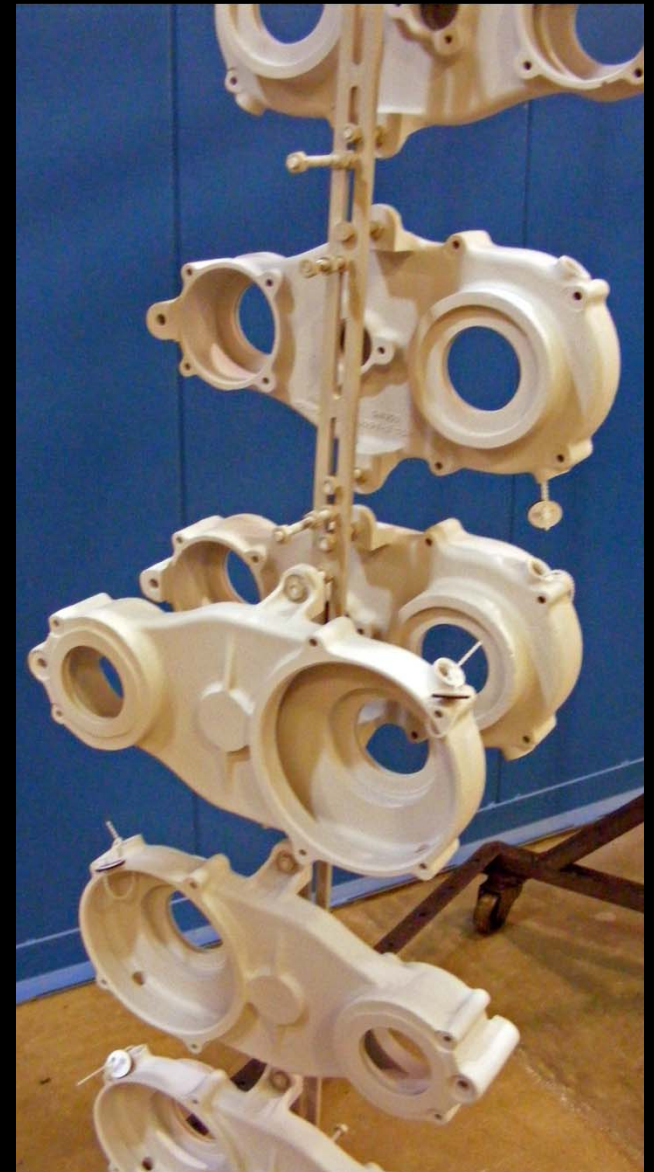
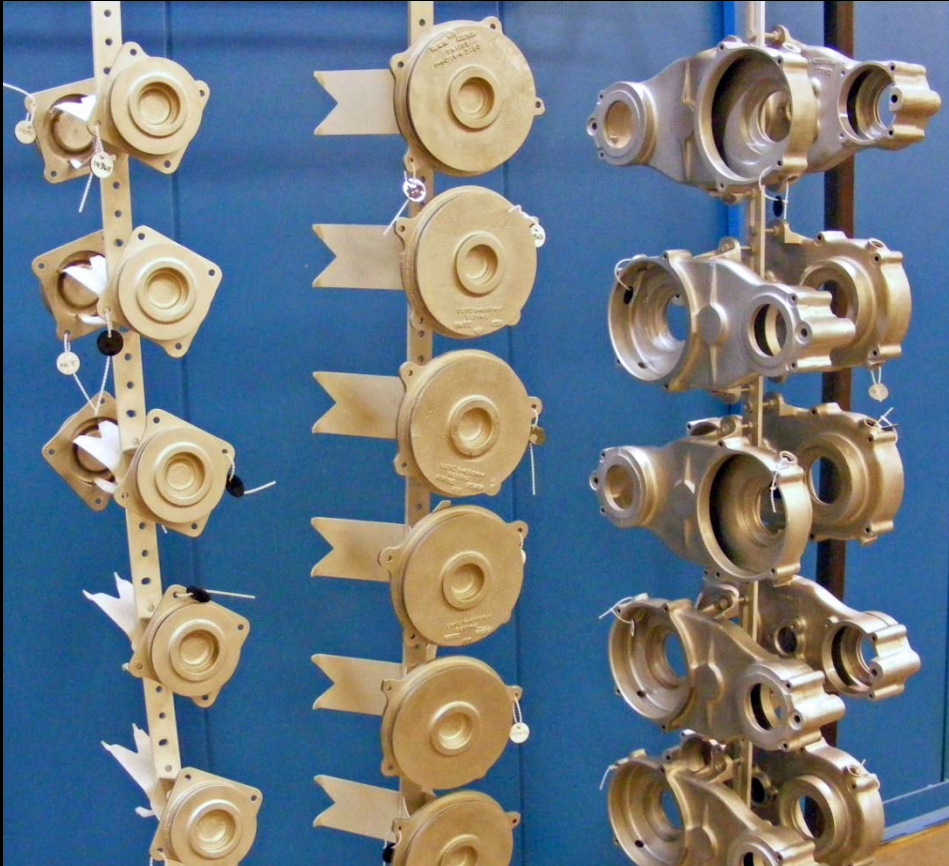
**Better Protected in 2011
Than When They Were
Factory New**



- Last KC-135 Was built in 1965
 - Air Force wants to keep them going until 2040
 - The KC-135 utilizes many magnesium components including several in flap drive system
 - The majority of these 45+ year old castings look good and are still serviceable
 - By selecting Tagnite, the Air Force was able to eliminate hexavalent chromium and attain corrosion resistance superior to standard chromate conversion coatings typically used during overhaul
 - Tagnite has been employed now on 15 different part numbers on the KC-135 approval process
- 

Magnesium Housings Used For Flap Drive Gearboxes





Do these look like 49 year old magnesium castings?

Old magnesium castings cleaned (above),
and then Tagnite anodized (right).

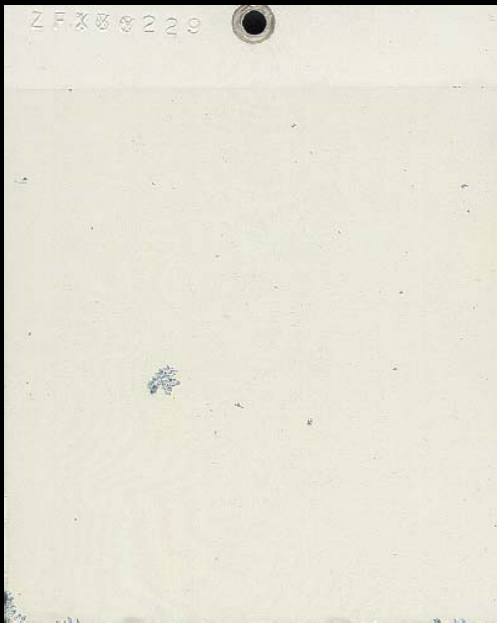
45 Year Old+ Magnesium Castings Re-Coated with Tagnite and Paint and Ready to Return to Service



45 Year Old+ Magnesium Castings Ready to Return to Service



Why Invest in the Added Time & Cost to Mask Ferrous Metal Inserts and Tagnite vs. Quick Inexpensive Chromate Conversion Coatings?



TAGNITE®
168 Hours
of Salt Spray



Dow 7
9 Hours
of Salt Spray



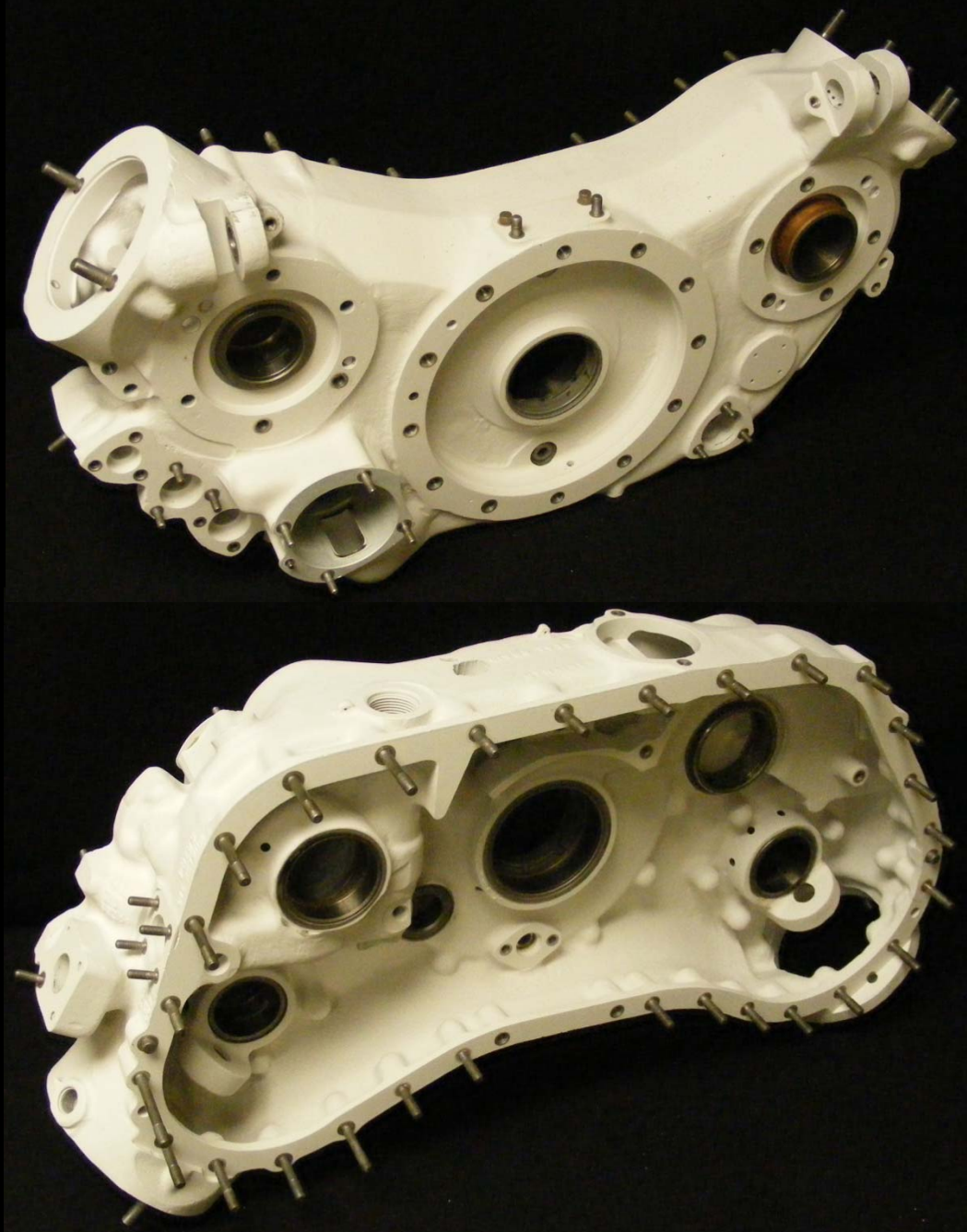
DOW 19
9 Hours
of Salt Spray



Jet Engine Gearbox

Successfully Tagnite
Coated After Masking:

6 Steel Bearing Liners
42 Helicoils
52 Studs



3 of the 6
Bearing
Liners had
Core
Passageways
Going
Through
Them Which
Would Allow
Electrolyte to
Penetrate to
The Steel
Liner.



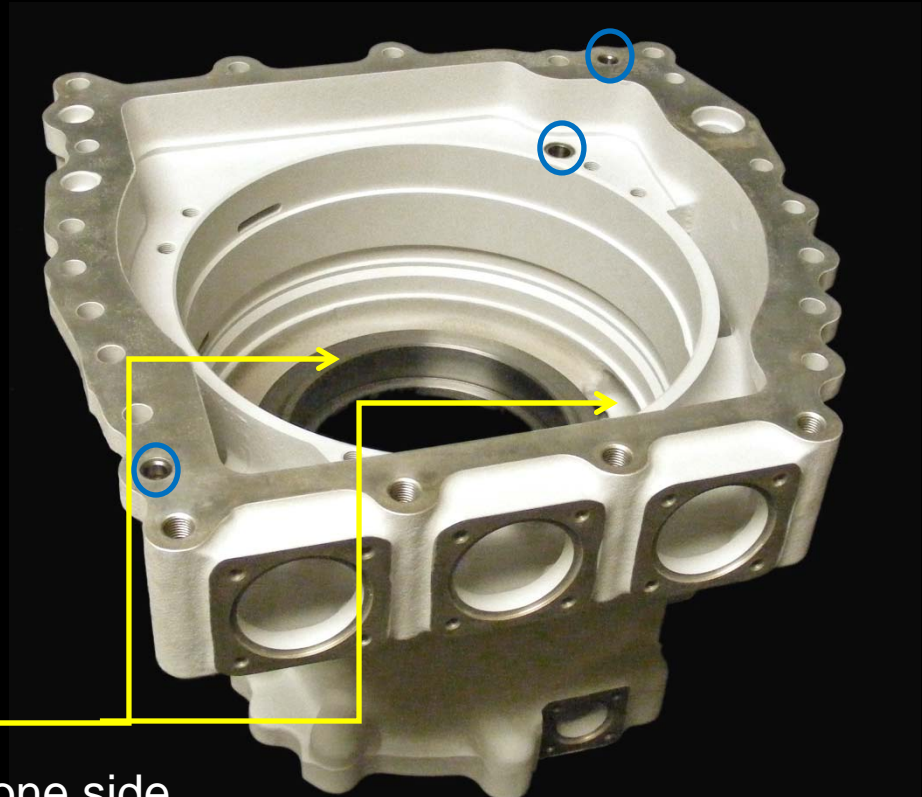
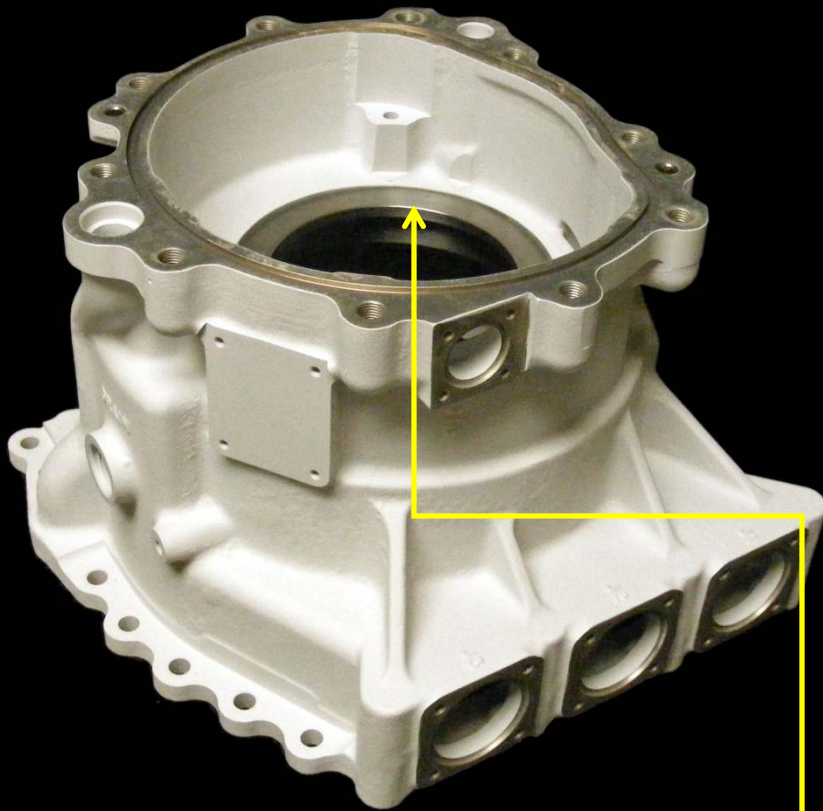


Extreme Masking
Challenges Have Been
Dealt With Successfully





New Casting in Production Requiring Extensive Masking of Ferrous and Magnesium Prior to Tagnite Anodize



Bearing Liner is flush with magnesium on one side
And raised above magnesium on other side. On raised side
a core passage way comes directly to bearing liner.

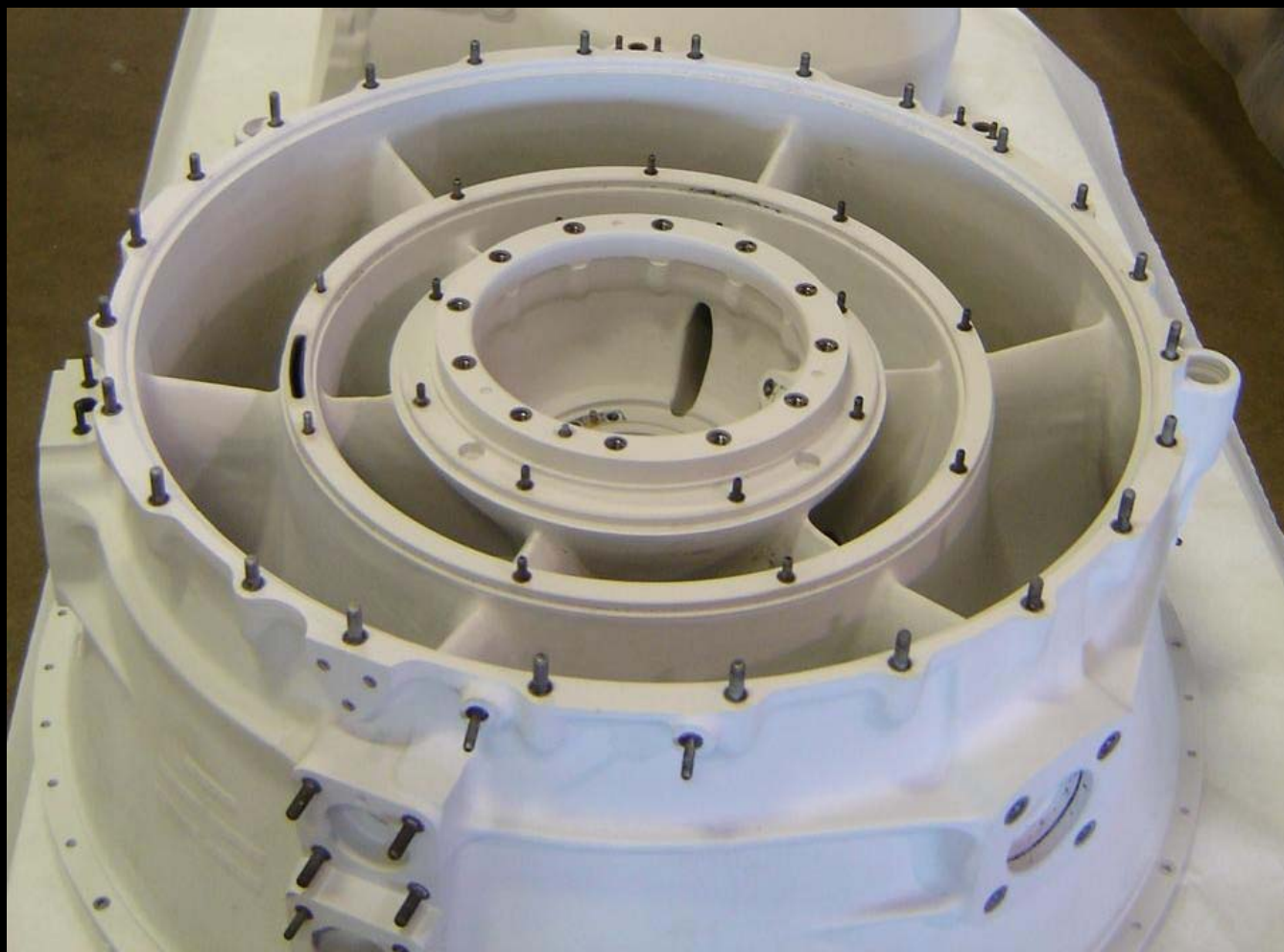
○ Multiple Pressed in
Steel Bushing



Jet Engine Intermediate Housing

Successfully
Tagnite Coated
After Masking:

121 Ferrous
Inserts





TECHNOLOGY APPLICATIONS GROUP
EXCELLENCE IN MAGNESIUM SURFACE PROTECTION

Approved by Many Aerospace and Defense Companies, Brush Tagnite is an Effective Method to Touch-up Magnesium Castings Without Using Hexavalent Chromium





TECHNOLOGY APPLICATIONS GROUP
EXCELLENCE IN MAGNESIUM SURFACE PROTECTION

Thank You For Your Time